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ORIGINAL ARTICLES.

I.—Coal in Spitsbergen.

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ALTHOUGH the existence of coal in Spitsbergen has been known for a very long time, it is only of recent years that development has been undertaken on any considerable scale. As early as 1610 explorers brought back with them small amounts of coal to burn on the voyage home, and in 1614 the islands were formally claimed for James I by the Muscovy Company. The coal was also described from the scientific point of view by Nathorst and others at various dates, but no attempt was made to work it till about 1904, when the Arctic Coal Company, an American concern, opened a mine at Advent Bay.

The Spitsbergen Archipelago is made up of a number of islands of a total area about equal to that of Ireland. The greater part of the land is divided between West Spitsbergen, which is by far the largest, and North-East Spitsbergen: the relative position of these two land-masses is implied by their names. In addition to these there are Prince Charles Foreland off the west coast of West Spitsbergen, and Barents Island and Edge Island lying south of North-East Spitsbergen. Structurally, the islands are part of the old North Atlantic continent, and are broken up by subsidences and bounded by fractures, which were accompanied by eruptions.

Along the west coast of West Spitsbergen there is a narrow belt of highly folded and crumpled rocks, which has been affected by several successive mountain-building movements, continuing down to Tertiary times; further east this folding, faulting and thrusting dies out, and the remainder of the island is made up of a high plateau with regular stratigraphy and gentle dips, deeply trenched by the inlets of Ice Fjord and Bell and Lowe Sounds, which extend far into the interior. In the western zone the older and newer strata are much folded together, and here the oldest rocks found in the island, the Hekla Hook formation, are exposed. These are limestones of Ordovician age, followed by Silurian quartzites, dolomites, and sandstones. They are succeeded by Devonian beds, which are the oldest rocks seen in the interior, and are composed of a mass of red strata very like the British Devonian. On these Carboniferous limestones and cherts rest with a strong unconformity, and are in turn followed by a belt of sandstones and shales referred to the Permian. Above these lie the Triassic strata, chiefly shales or clays

with thin limestones, sandstones, and phosphate beds, often rich in well-preserved marine fossils. After these follow Jurassic and Tertiary strata, which are very thick and in apparent conformity: these build up the high plateau of Ice Fjord. They are chiefly composed of sandstones and shales of marine origin, with occasional bands containing marine fossils. They also yield abundant plant remains and both contain coal, in consequence of which they are the most important strata in the islands from the economic point of view.

The age of the coals is somewhat undecided: in 1897 Nathorst determined the age of some of the seams to be Upper Jurassic, and he considers that those on the west side of Advent Bay are Tertiary, while the American writers Stevenson and Morris believe that they are all Jurassic. Bituminous coal, cannel coal, and anthracite are all found in the islands. Generally speaking, the carbon percentage is very variable, especially between the top and bottom of the individual seams, and the ash content is high. The coals, however, are good for steam-raising, and especially so for use in closed stoves, which makes them particularly well suited for export to Scandinavia and Russia. Four analyses from the Green Harbour–Advent Bay district gave the following results:—

	Per cent
Coke production	54–60
Gaseous content	37–44
Ash	3·8–5·6
Water at air drying	3–4
Water at 100° C.	1·5

The heating capacity of these samples was 12,000 British thermal units.

The coal is mined both in the folded zone and in the plateau region. In the latter the beds have a gentle dip, and the seams can be seen cropping out on the hillsides generally between 450 and 600 feet above the sea, though they are known to exist up to 1,300 feet, but at this height they are unworkable, partly owing to the cold and partly to the steepness of the slopes. For the mining of these flat or gently dipping seams shafts are unnecessary, since all the seams can be worked by adits driven in from their outcrops. No fire-damp has been met with and the mines can be worked all the year round in spite of the temperature, which is always as low as −4° C. in the drives, so that the coal faces are covered with ice or hoarfrost. The steepness of the slopes renders transport somewhat difficult, and at one mine on Advent Bay the coal is brought down to the wharf by an aerial ropeway. On the other side of Advent Bay a tramway is in operation and a railway is projected from the Swedish concessions in Buntzow's Land at the head of Ice Fjord to an ice-free harbour on Bell Sound.

The coal-seams average about 3 feet in thickness, though some have been reported up to 12 feet thick: they are often pure coal throughout, though at some places, such as Green Harbour and Advent Bay, they are known to split. At the former locality there are two coal-seams, the upper one of which splits as follows:—

	ft.	in.
Pure coal	3	0
Coal slate	1	0
Pure coal	1	6

while at Advent Bay there are two intermediate beds, aggregating 2 feet, separating three coal-seams which together have a thickness of 5 feet.

The coal areas in West Spitsbergen are nearly all included in an irregular quadrilateral, 100 miles from east to west by 130 miles from north to south, the boundary extending from the Brogger Peninsula on the west coast to Wiche Bay on the east, thence south to Whales Bay and across to the west coast again at Dunder Bay. In addition, coal claims have been taken up at Hope Bay and all over Prince Charles Foreland and Barents Island. The coal districts on the main land are all situated either near open sea or near navigable waters in Ice Fjord and Bell and Lowe Sounds, where the coal can be loaded directly on to the ship. They are owned by several different nationalities in the following proportions:—

	Square miles.
British	3,574
Norwegian	770
Swedish	448
Russian	80
German	23

The British claims are situated on Prince Charles Foreland and at Kings Bay and Brogger Peninsula, around Bell and Lowe Sounds, in the district west of Wiche Bay, at Hope Bay, and on Barents Island. The Norwegian and Russian claims are on the south shore of Ice Fjord, the Swedish in Buntzow's Land at the head of Ice Fjord and at the head of Lowe Sound, and the German near Kings Bay.

The chief British company operating in the islands is the Northern Exploration Company, which owns 2,000 square miles of claims and which instigated the large expedition organized by Sir Ernest Shackleton, which has recently returned to this country. Another British company is the Scottish Spitsbergen Syndicate, of Edinburgh, which puts forward claims to the Buntzow's Land district, at present occupied by the Swedish Spitsbergen Company. There are also two large Norwegian companies, one of which recently acquired the American Arctic Coal Company's mine at Advent Bay.

The last-named company, which began work in 1904, had an annual output of about 50,000 tons, and this together with some coal mined by a British company at Green Harbour, also on the south side of Ice Fjord, was the whole output of the islands till the outbreak of war in 1914: at that time development on a much larger scale was planned, but was unavoidably postponed, so that the total output for 1917 was only 100,000 tons, all of which was exported to Norway and Sweden.

The coal reserves of the islands have recently been estimated at 8,000,000,000 tons, a figure which is probably considerably below the mark, if the reports of the Swedish company may be trusted.

This company alone estimates that the reserves in its holdings are as follows:—

	Tons.
Braganza District	340,000,000
Pyramide Mountain	380,000,000
Buntzow's Land	3,000,000,000

The Swedish holdings are small compared with the British, and, unless the former are abnormally rich, it must be assumed that the available reserves are many times as great as the figures quoted above, and it seems probable that Spitsbergen will ultimately be able to supply all the coal required by Scandinavia and North Russia. For this trade the British-owned fields are most advantageously situated; lying as they do chiefly north and south of Bell and Lowe Sounds they are nearer and more accessible for ships plying to these countries, and they can obtain and hold a dominant position if the requisite facilities are given.

In addition to coal the islands possess other mineral resources, notably marble, which is said to be of good quality; the British-owned territories are highly mineralized and contain deposits of hematite, magnetite, copper ores, iron and copper pyrites, molybdenite, galena, zinc-blende, and other minerals, the development of which has been held back by the war. Very optimistic reports have lately been issued as to the resources of iron-ore, which are said to be of nearly as high quality as the Swedish ores, and to be of enormous extent: these statements, however, seem to need confirmation.

The political situation in Spitsbergen is at present in rather an indefinite position; attracted by the success of the American and British enterprises, Norwegian, Swedish, and Russian prospectors landed and began to "peg out" claims, and in 1912 the archipelago was visited by Prince Henry of Prussia and the late Count Zeppelin. A wireless station, which has since been dismantled, was erected by the Germans, who also "pegged out" coal claims. Spitsbergen, however, is one of the few remaining countries not under the government of any great Power, and may be classed as a No Man's Land. In consequence of this there was no control of the claims, and a considerable amount of overlapping and "jumping" occurred. To settle this question an International Congress was held at Stockholm in 1912, at which delegates from Sweden, Norway, and Russia were present. This Congress, however, accomplished nothing, and it now seems probable that the islands will become internationalized, since their British ownership long since fell into abeyance.

II.—Notes on Yunnan Cystidea. II. The Species of *Sinocystis*.

By F. A. Bather, D.Sc., F.R.S.

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Sinocystis loczyi Reed. (Text-figs. 5, 8, 9, 10, 11.)

Specimens I, 1–8 were studied. Probably those measured under Dr. Reed's heads I and II refer to 1 and 3 respectively. Specimen 1 is hereby selected as Holotype.

The following are measurements in millimetres:—

Specimen .	1		2		3		4		5		6	7
Height .	74·7		71·0		79·0		60·0		17·5			
Greatest	44·5	40°	58·0	160°	56·6	80°	45·3	25°	18·2	5°		
diameters	43·8	160°	43·0	60°	53·7	0°	35·8	130°	16·4	100°		
Diameters	11·0		13·9		*ca.* 8·5		15·0		7·3		10·7	9·0
at base	9·0		10·4				10·3		6·3		8·1	*ca.* 8·5
Peristome		95°		106°		80°		95°		105°	—	—
plane												

Specimen 8 consists of two rather large but incomplete individuals in matrix.

In order to indicate the planes of compression, the oro-anal plane is marked 0°–180°, 0° being anterior, or North in the usual orientation of drawings of the adoral face. The angle formed by each plane of compression with the oro-anal plane is reckoned in degrees on the right-hand side. The direction of the extended peristome is denoted in the same way. From this it will be seen that the compression bears no constant relation to any morphological plane, and is therefore due to causes acting after death. The theca was essentially ovate-pyriform, and its true diameters may be roughly estimated by taking the mean of the double measurements. The theca was upright (1, 3, 5?, and 6), or bent over on its stalk (2) so as apparently to have almost lain on the sea-floor; but since in this case the anus would thus be facing the sea-floor, it is more likely that the base was fixed to the side of some object.

The variation of angle between the peristome plane and the anal plane may be regarded as due either to a shifting obliquity of the mouth or to the migration of the anus. If checked by reference to the hydropore, it will be found that the former is probably the truer statement. The bearing of this decision appears when one examines the four branches, their direction and diverse lengths. It will then be observed that the peristome is *not* an oblong, parallel to the hydropore and at right angles to the anal plane, with four equal branches, passing one from each corner at equal angles. It is the departures from that simple but imaginary scheme which are of real interest, as pointing to the original plan of which the existing ones are modifications (Text-fig. 8). The extreme of departure is provided by I, 2, but similar features are seen, though less marked, in I, 1, 3, and 4. First, as already shown by the table of measurements, the peristome lies at an angle to the anal plane of 106°, or 16° in excess of a right angle. Secondly, the hydropore slit, which is never quite straight, but concave towards the mouth in a more or less symmetrical curve, is neither parallel to the peristome nor symmetrically placed in regard to it; on the contrary a line joining the centres of hydropore and anus will, if produced, meet the peristome at its left end, just where the branches diverge. Thirdly, the branches do not form equal angles with the peristome. The two branches on the left include an angle rather greater than 90° (actually 110° in specimen 2), and the peristome plane does not bisect this angle but lies anterior to its bisection. On the right the angle included by the branches is about 90°, and here the peristome plane lies posterior to its bisection, and that in an even greater degree. Fourthly, the branches are of diverse length; the left

posterior is always the longest: in I, 2 it is 8 mm. long; next comes the left anterior, 5·4 mm.; then the right anterior, 4·5 mm.; and lastly the right posterior, 3·3 mm. The length of the peristome between the forks is 7 mm. The conclusion to which these facts lead is that the four-rayed and approximately quadrangular subvective system of *Sinocystis* is really a modification of the three-rayed system, which I have previously held to be the primitive arrangement in Pelmatozoa (1900, Treatise on Zoology, p. 11, and elsewhere). On this view, the true or primitive oral centre lies at the axil of the left fork; the anterior of the two branches on the left is the true anterior ray, and it is noteworthy that, in I, 2 at any rate, its line if produced almost coincides with the line joining hydropore and anus; this, then, marks the true or primitive sagittal plane, coincident, as it should be, with the M plane (Text-figs. 2, 4);

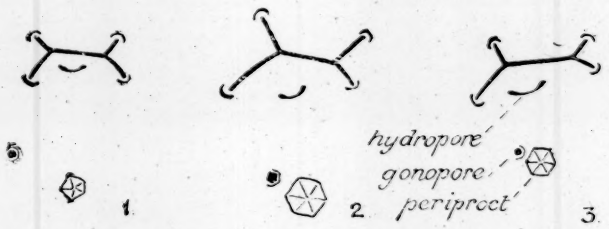

FIG. 8.—*Sinocystis loczyi*: diagrams, taken as accurately as possible from specimens I, 1, 2, and 3, to show the varying relations of the subvective system to the thecal openings. All are oriented with the anal plane running N. and S., the oral pole being taken as midway between the forks. If the oral pole were at the origin of the left-hand fork, then a line joining it with the anal pole would pass through the hydropore, and (in 2 and 3 at any rate) would be continuous with the anterior branch of the fork. This line would then represent the primitive sagittal plane, and the branch would be the anterior of the primitive three rays (cf. fig. 4, *antea*, also Treatise on Zoology, 1900, p. 11, fig. IX). Nat. size.

the posterior of the two left-hand branches is the primitive left posterior; and the line of the peristome marks the primitive right posterior branch. This last branch (one supposes) after a time bent slightly towards the anus, and gave off a branch, which in *Sinocystis* is the right anterior. This is precisely the same change as took place in the evolution of any normal five-rayed pelmatozoön, but there the left posterior branch also forked in the same way, thus completing the quintet.

The Brachiole-facets, which, owing to the biserial structure of the cystid brachiole in general, are composed of two halves, are seen in I, 1, 2, and 4, but by no means clearly (Reed, pl. I, fig. 2*a*, left anterior branch, is the clearest representation). In some cases there is a suggestion of more than one facet at the end of a main branch (see Reed, pl. I, fig. 4, right anterior branch); if there were actually two facets, it would imply a forking of the branch, in which there is nothing impossible.

The relation of the adjacent thecal plates to the Subvective

System is not quite clear and does not seem to be constant. Each facet appears, as Dr. Reed says, to be "situated in the centre of a slightly swollen ordinary thecal plate". The hydropore seems at first glance to be on a single plate, adjoining the peristome and filling the posterior interradius. On the other side of the peristome, in the opposite interradius, two plates are discernible in I, 4, and perhaps in 2 and 3. The thecal plates adjacent to the hydropore-plate suggest that it too is really compound, and this view is supported by *S. mansuyi*, II, 9 (see Reed's figure). It is usual for a hydropore-slit of this shape to cross a suture. This would give 8 adoral plates, of which the right and left pairs would bear facets; the posterior pair would bear the hydropore, and the anterior pair would bear nothing (Text-fig. 9). The occurrence in all species of *Sinocystis* of diplopores on all these plates, right up to the facets, grooves, etc., is noteworthy (Text-fig. 12).

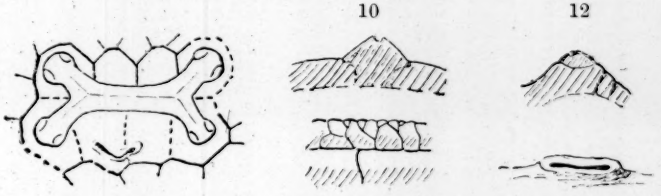

FIG. 9.—*Sinocystis loczyi*: diagram of the eight adoral plates. The broken lines are restored by me; all others are traced from Mr. Brock's drawing (Reed, 1917, pl. i, fig. 4). × 8.

,, 10.—*Sinocystis loczyi*: section across the peristomial ridge; the exterior outline based on I, 4; the interior imaginary. The summit notch is due to weathering. × 8.

,, 11.—*Sinocystis loczyi*: side-view of a part of the peristomial ridge in I, 4, to show how the cover-plates interlock. × 8.

,, 12.—*Sinocystis mansuyi*: section across a subvective groove as seen in II, 7. Note pore-canals of a diplopore on the right. × 8.

,, 13.—*Sinocystis mansuyi*: the hydropore in II, 2. × *circa* 8.

Dr. Reed says of *S. loczyi* "mouth narrow, straight, slit-like, slightly raised". It is not certain what he means by "mouth". Apparently the sentence quoted refers to the thread-like slit clearly shown in pl. I, fig. 4 (cf. Text-figs. 9, 10). This, however, is not a natural opening into the thecal cavity. The peristomial aperture is not actually visible in any of the figured specimens. From the disposition of the cover-plates, however, supported by the evidence of closely similar fossils from elsewhere, it may be inferred that the peristome in I, 1 was an oblong, measuring about 4·5 mm. by not more than 2 mm. The aperture and the grooves leading from its corners to the brachiole-facets were, as Dr. Reed says, "covered with a double row of small alternate polygonal plates set in a narrow rebate around their edges [i.e. of mouth and branches] and forming a roof-like ridge." The arrangement of the cover-plates is shown, though not very clearly, in Reed, pl. I, fig. 2*a*. It may be better understood from the annexed side-view of the tegminal ridge in I, 4

(Text-fig. 11). Resting on the rebate is a series of squarish plates, with their upper angles irregularly bevelled off. On the larger shoulder of each such plate rests a triangular plate; in side view this does not appear triangular because its apex is bent over on to the other side (as seen in I, 2). The apices of the corresponding triangular plates of the other side, similarly bent over, are seen resting on the smaller shoulders of the squarish plates. There are slight deviations from this general structure, but the essential fact to notice is that the triangular plates cross the median line and interlock. The appearance forcibly suggests that the cover-plates did not open but formed a fixed tegmen. In any case a slit which, as in I, 4, cuts across the triangular plates, cannot represent a natural opening.

The Hydropore has been mentioned in connexion with the orientation of the subvective system. It is always concave towards the peristome and tends to face its left corner (the supposed primitive oral pole). In I, 4 the slit seems to branch at its right end, but probably there is a small root of another cystid growing across it (omitted in Text-fig. 9).

The following are some measurements in millimetres of the hexagonal Anal pyramid:—

Specimen . .	1	2	3	4	5
Least distance of anal centre from edge of peristome . . .	18·0	17·0	12·8	10·2	4·8
Diameter, side to side . . .	3·7	4·5	3·7	3·0	3·2
,, angle to angle . .	4·0	5·8	4·7	3·7	3·6
Length of peristome, *circa* . .	4·5	5·8	6·0	5·2	3·0

The approximate length of the peristome is introduced for comparison with Dr. Reed's statement that the anus is "distant from it [the 'mouth'] about twice its [the 'mouth's'] length". According to the fixed points selected for the above measurements, this ratio of 2 : 1 holds for specimens 3 and 4; the ratio for I, 1 is 4 : 1; for I, 2, 3 : 1; and for I, 5, 1·6 : 1. Arranging the specimens in order of size, downwards, the ratios are 2, 3, 4, 2, 1·6. The chief interest lies in the irregularity and lack of any correspondence between size and position, which indicate that the anus did not migrate appreciably during growth (*v. supra*, p. 534).

The Gonopore is subcircular with a tendency to be pentagonal, this outline suggesting that the opening was closed by five valves, though no other traces of them are preserved.

The following measurements in millimetres show that irregularity also obtains in the distance of this from the anus:—

Specimen. . .	1	2	3	4	5
Distance of Gonopore centre from anal centre	9·2	6·0	3·7	4·3	3·7
Diameter of Gonopore lumen, *circa*	—	1·4	1·3	·6	—

The edge of the gonopore is raised slightly in I, 3, 5, and conspicuously in 4; in I, 2 the rim is very faint, and in I, 1 not distinguishable. In I, 4 and 5 the line joining the anal and gonopore centres is parallel to the peristome; but in I, 2 and 3 the gonopore is slightly nearer the peristome. It is always to the left of the anal plane (cf. Text-fig. 8).

The actual Base of Attachment is well shown in I, 2 and 6; it is slightly expanded, very slightly excavate, and in I, 5 is extended in the anal plane. The "stalk" is not a specialized stem, but merely a narrowing of the theca; in I, 6 and 7, however, the plates in the lower part of the theca are arranged transversely; and this is marked, especially in I, 6, by a transverse alignment of the pore-tubercles.

There is little to add to Dr. Reed's full account of the plates and their structure. The diameters of the plates in I, 1 range from ·7 mm. to 6·5 mm. There is an occasional tendency for a large plate to be surrounded by smaller ones. The diplopores have already been discussed (p. 512, Text-fig. 5). The inner face and the margins of the plates are not exposed.

Sinocystis yunnanensis Reed.

Of the four specimens mentioned by Dr. Reed, the three figured ones have been studied, viz. I, 9, 10, and II, 1. Of these I, 10 is certainly identical with No. II in Reed's table of measurements; but, since his measurements are estimated, his No. I cannot be identified. "The largest," he says, "is the best preserved"; probably this is I, 9. But II, 1 is hereby selected as Holotype, because it seems to show the openings more clearly than do the others.

The following are actual measurements in millimetres:—

Specimen	9		10		1	
Height	97·0		44·0		76·0	
Greatest diameters	81·7	10°	35·8	? 0°	65·0	25°
	37·0	110°	27·4	?90°	30·6	110°
Diameters at base	——		8·3		——	
	——		6·9		——	
Peristome plane		?90°		?90°		105°

(For explanation of angles, see under *S. loczyi*.)

The cover-plates are relatively large, irregularly triangular, alternating, and interlocking.

Hydropore-slit concave towards peristome; its middle line about 3·2 mm. from middle line of peristome in II, 1, a little further in I, 9.

The Anal pyramid is seen in II, 1, its centre 20 mm. from edge of peristome; diameter of hexagon, side to side, 5·5 mm.; height above general surface, about 2·2 mm.

Gonopore seen in II, 1, at 7·7 mm. to left of anal centre.

The Basal Attachment is seen only in I, 10; it is somewhat cylindrically excavate along its greater diameter, which corresponds approximately with the shorter diameter of the theca and with the peristome plane. The theca is rather sharply bent over on its stalk, apparently to the left, so that there was a mechanical advantage in this shape of the attachment.

The plates may attain a diameter of about 7 mm. in the larger specimens. They are about ·7 mm. thick in the middle region of II, 1. Their margins are irregularly crenelate, especially on the inside edge. The crenellæ do not appear on the outer suture; they are in no relation to the diplopores.

The diplopores have already been discussed (p. 512); in spite of their radiating arrangement they never cross a suture. The canals pass in a straight line vertically or obliquely through the plate, emerging on the inner face in marked depressions, between which the surface is raised in irregular prominences.

Sinocystis mansuyi (Reed, 1917, sub *Ovocystis*). (Text-figs. 3, 4, 6, 7, 12, 13.)

Of the "nearly sixty specimens" mentioned by Dr. Reed the ten figured ones have been studied, viz. II, 2 to 11. None of these seems to correspond with either I or II of Reed's table of measurements, which indicate much larger individuals; but II, 6 corresponds fairly with his III. Although one of the smaller individuals, this specimen is one of the more complete, and is therefore hereby selected as Holotype.

The following are actual measurements in millimetres:—

Specimen	2	3	4	5	6	7	8	9	10	11
Height	62·0	68 +	60 +	46·5	46·8	34·0	69 +	65·0	58 +	48·5 +
Greatest diameters	43·0 115° 29·0 25°	39·8 ?95° 24·0	39·6 ?95° 27·0 ?	30·0 ?10° 27·0 ?100°	25·2 24·8	22·2 20° 20·6 120°	46·5 0° 30·0 90°	45·0 170° 25·0 80°	40·4 ?95° 24·8 ?5	30·9 ? 25·5
Diameters at base	5·8 5·4	6·4 5·7 broken	not preserved	5·1	4·8 4·0 broken	broken	not preserved	not preserved	not preserved	6·3 5·5 broken
Peristome plane	?95°	?95°	?95°	?100°	100°	95°	95°	100°	?95°	not preserved

(For explanation of angles, see under *S. loczyi*.)

The crushing makes it difficult to get the orientation, and in several cases the anus is not preserved or not clearly seen. There appears, however, to be little variation in the angle formed by the peristome plane with the anal plane; it is between 95° and 100°.

As may be seen from Dr. Reed's pl. II, figs. 7, 8, and less clearly from figs. 6, 9, the relative positions of the thecal openings are as in *S. loczyi*; a line drawn from the anal centre through the hydropore would approximately coincide with the line of the left anterior food-groove.

Reed's figs. 7 and 8 also show that the branches of the subvective system are not really equal. As in *S. loczyi*, the left posterior branch is the longest, and the right posterior is the shortest (specimens 6, 7, 8).

The angle at which the branches of each pair diverge may in some specimens be 60°–90° as stated; but as measured in the figured specimens, it varies between 90°, as in the left pair of II, 7 and 9, and 140°, as in the right pair of 7; in the right pair of 9 it is 130°; and in 8 it is 105° on the left, 106° or more on the right. These measurements are confirmed by Mr. Brock's drawings.

The Brachiole-facets are far from clear, so that one does not like to lay too much stress on the occasional suggestion of two facets to the branch, as in *S. loczyi* (see Reed, pl. II, fig. 8, r. ant. branch), especially since Dr. Reed does not mention it. Note in fig. 8 how very close the diplopores are to the food-grooves (also our Text-fig. 12). The elevation of the thecal plate on which the facet rests is, in this species, called by Dr. Reed an "oral boss": would not "brachiole boss" or "facet boss" be more appropriate?

The cover-plates are perhaps a trifle heavier than in the other two species, and are swollen. A section across the grooves is afforded by II, 7 (Text-fig. 12).

The Hydropore-slit (Text-fig. 13) is almost straight, has thickened edges, and the lumen expands slightly at the two ends (II, 2, 8, 9); in 5 it is covered by an attached object like the lower valve of a brachiopod; and in 10 it is crushed close up to the peristome. Dr. Reed describes it as "parallel to the mouth in a line joining the right and left anterior [i.e. posterior] oral bosses". It would perhaps be even more exact to substitute the words "brachiole facets" for "oral bosses", and to note that the line joining them is not quite parallel to the peristome, but further from it on the left side. Also the hydropore approaches this left end, and thus its deviation from perfect symmetry with reference to the peristome is in the direction of symmetry with reference to the left anterior food-groove. The bearing of this on the nature of the primitive symmetry is the same as in *S. loczyi* (see p. 535).

The length of the slit is 4·5 mm. in II, 2; 2·3 mm. in II, 6; 9 mm. in II, 7; 3·8 mm. in II, 8; 4·4 mm. in II, 9. Dr. Reed's numbers are presumably over-all measurements.

The Anal pyramid, according to Dr. Reed, is pentagonal. No doubt this is correct for most of the specimens, but in the figured specimens it was not so clear to me as to Dr. Reed and Mr. Brock. My notes run: "In II, 8, about 16 mm. from peristome, hexagonal, but covered by a base with stem 4 mm. long, 6·1 mm. wide below, 3·4 mm. wide above; diameter of pyramid, side to side, *ca.* 5·7 mm. In II, 6, 10 mm. from peristome, ? hexagonal or pentagonal, diameter *ca.* 5 mm., rather elevated—say, 1·3 mm. Elevated about 1·5 mm. in II, 7."

The Gonopore lies to the left of the anus, distant from the anal centre by 6·6 mm. in II, 6; *ca.* 9 mm. in II, 8. In 8 it is elevated above the general surface *ca.* 1·5 mm. and has a diameter at the top of 1·6 mm. The diameter of the lumen is *ca.* 1 mm. in II, 8; ·6 mm. in II, 5 and 6. In 6 the lumen is clearly pentagonal.

The stem-like appearance of the Base is rather more pronounced in such specimens as II, 2 and 6 than it is in *S. loczyi*; but it is approached by *S. yunnanensis*, I, 10. Owing to its sudden contraction and projection from the egg-shaped theca, it has been broken off in most of the (figured) specimens. This enables one to give the following additional measurements in millimetres:—

Specimen	3	5	6
Thickness of plates . . .	0·85	1·8	0·9
Diameter of lumen . . .	4·6	1·6	*ca.* 2·5

From these it follows that the plates increase in thickness as the lumen contracts towards the distal end.

The base in II, 11 (see Reed's figure) is built of five sub-equal plates, about 3 mm. high, slightly broken below. These are succeeded by a circlet of seven plates.

The thickness of the plates, as measured in II, 10, a little above the base, is ·5 mm. The plates are described fully, and figured

accurately by Dr. Reed; but it may be added that the sutural edges are faintly crenelate (II, 2), and this appearance, though not specifically mentioned by him, may have, consciously or unconsciously, prompted his belief that subvective grooves ran along the depressed sutures.

III.—Note on some Fossil Mammals from Salonica and Imbros.

By C. W. Andrews, D.Sc., F.R.S. (British Museum, Nat. Hist.).

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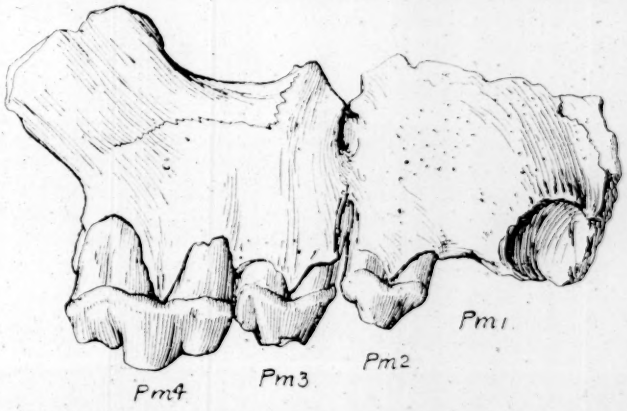
On several occasions during the War, officers on active service in the Near East have found time to collect a few fossils, some of which have been sent to the British Museum. In three cases these were remains of mammals, and these discoveries are of importance as indicating the existence of bone-bearing deposits in localities where they were previously unknown, and where, not improbably, they may prove to be as rich as the well-known bone-beds of Samos and Pikermi.

The most interesting specimen from near Salonica is a nearly complete right maxilla, with portions of the premaxilla and jugal, of a very large species of *Hyæna*. This fragment is in a beautiful state of preservation: the second, third, and fourth premolars are entire, while the canine and first premolar are represented by their sockets and the first molar by its outer root. The bone is hard and nearly white, with irregular patches of black stain which give it a peculiar piebald appearance: some specimens from Maragha are in an almost identical state of preservation. An incomplete skull and other fragments of *Hipparion* from the village of Dudular, N.N.W. of Salonica, are in exactly the same condition, and no doubt the *Hyæna* jaw was from the same deposit (see Text-figure, p. 541). This fixes the age as Upper Miocene, and therefore contemporary with the bone-beds of Samos, Pikermi, and other localities in which the Pontian fauna is found.

In front the bone is preserved as far as the suture with the premaxilla, a narrow strip of which remains. Above, the facial portion is somewhat incomplete, while posteriorly the bone joins the jugal, which bears a blunt, somewhat forwardly directed postorbital process. Above the canine the surface is very convex owing to the very large size of the alveolus of that tooth. The relatively small antorbital foramen is situated vertically above the anterior root of p.m. 3. The lower border of the orbit, so far as preserved, differs from that of other Hyænas with which it has been compared (*H. crocuta*, *eximia*, etc.) in being less sharply separated from the facial surface, but passing into it by a gentle curve; the postorbital process of the jugal also differs in being blunt and turned forward, instead of pointed and more or less turned backwards: unfortunately this region is wanting in the type of *H. brevirostris*, Aymard,[1] to which the present species is in some respects similar. Judging from its alveolus the canine must have been a very large tooth.

[1] Boule, *Annales des Sciences Naturelles, Zoologie*, vol. xv, p. 85, pl. i, 1893.

larger proportionately than in the other Hyænas; it measured about 25 mm. across at its root, and its hinder border is separated from the small round alveolus (diameter 6 mm.) for p.m. 1 by an interval of 8 mm. P.m. 2 is separated from p.m. 1 by a space of about 4 mm.; it differs from p.m. 2 in *H. brevirostris*, with which it is comparable in size, in not having the cingulum developed on its anterior or external faces, and in the much smaller size of its posterior accessory cusp; the tooth is also less convex on its outer face. P.m. 3 is similar in most respects to that of *H. brevirostris*, but narrows more towards its posterior end where it has a larger accessory cusp. The long axes of these two teeth are in the same straight line. P.m. 4 (the carnassial) is much like that of *H. brevirostris*, having a well-developed inner cusp (protocone), which distinguishes it from the contemporary *H. eximia*. In *H. gigantea*, Schlosser,[1] a large *Hyæna*



Right maxilla of *Hyæna salonicæ*, n.sp. p.m. 1, socket of first premolar; p.m. 2–4, second to fourth premolars. One-half nat. size. From the Upper Miocene, near Salonica.

from a bed of similar age in China, there is only a greatly reduced inner cusp in p.m. 4. M. 1 is represented by its outer root only, but was probably of considerable size as in *H. brevirostris*, and much larger than in *H. crocuta*, where it is very small or even wanting.

The dimensions (in millimetres) of the teeth in the present species and in *H. brevirostris* are—

	Hyæna salonicæ.		*Hyæna brevirostris.*	
	Length.	Width.	Length.	Width.
p.m. 2 .	22·5	15	22	16
p.m. 3 .	28	19	27	21
p.m. 4 .	45	25	44·5	25

The length and width of the carnassial (p.m. 4) in *Hyæna gigantea*, Schlosser, are 44 mm. (?) and 25 mm. respectively.

As will be seen from the above measurements, this very large species is comparable in size with *Hyæna brevirostris*, Aymard, and *H. gigantea*, Schlosser. From the former it is distinguished not only

[1] Schlosser, Abhand. bayer. Akad. Wissensch., Bd. xxii, p. 35, 1906.

in the several structural points referred to above, but by its much earlier date, *H. brevirostris* occurring in Upper Pliocene beds in France, associated with *Equus stenonis*. *Hyæna robusta*, Weithofer,[1] from the Val d'Arno, is regarded as identical with *H. brevirostris*. From *H. gigantea* our fossil is sharply distinguished by the characters of the upper carnassial. There seems no doubt that the present is a new species, for which I propose the name *Hyæna salonicæ*, n.sp., the type-specimen being the right maxilla (B.M., No. M. 11413) above described and figured: it was collected by the Rev. Wilberforce Cooper, C.F., and reached the Museum through the agency of Cyril Brett, Esq., in 1916.

The remains of *Hipparion*, as already noted, are from the village of Dudular, N.N.W. Salonica: they were collected by Capt. Seymour W. Davies, R.A.M.C., and presented by him to the Museum. The specimens (M. 11585–6) include the occipital portion of a skull, both maxillæ, premaxillæ, symphysial portion of mandible, and some fragments of limb-bones.

The portions of the skull seem to have belonged to a rather large individual, which, judging from the presence of a well-developed canine, was probably a stallion. The teeth are in a most perfect state of preservation, at least on the right side, where the outer coat of cement, so often lost, is completely preserved. There seems to be no doubt that these remains are referable to the widely-spread species *Hipparion gracile*.

The length of the molar-premolar series is 149 mm., and the width across the occipital condyles is 78 mm. The limb-bones are represented by portions of tibiæ and of a radius and ulna.

All the above specimens terminate in sharp, clean fractures, indicating that much was left behind, and that careful collecting might yield very important results.

Portions of a mandible and limb-bones of a large Mastodon from the island of Imbros, off the mouth of the Dardanelles, were collected by Lieut. Riffault, R.A.M.C., and Col. Girvin, A.M.S., and were sent to the Museum by Capt. Percival T. Priestly, M.B., R.A.M.C., in 1916 (M. 11587–8).

The remains found in this case are unfortunately very imperfect, and were enclosed in a very refractory matrix. The chief specimen is the imperfect right ramus of a mandible with one broken molar in situ. This tooth seems to have been trilophodont: the outer lobes are worn into a trefoil pattern, the ends of the trefoils being formed by cusps blocking the transverse valleys, as in such forms as *Tetrabelodon angustidens*. The bone is broken away immediately behind the tooth, but extends in front of it as far as the posterior part of the symphysis, the length of which cannot be determined. The ramus is deepest at the back, narrowing gradually towards the symphysis. The sharp alveolar border is nearly straight, while the ventral border curves down slightly at the symphysis. There is some evidence that there was a lower incisor of considerable size, and in that case the species would be referable to the genus *Tetrabelodon*.

[1] Weithofer, Denksch. Akad. Wissensch. Wien, Bd. lv, p. 346, 1889.

Very probably it is *T. pentelicus*, a form described by Gaudry[1] from Pikermi.

The length of the portion of the mandibular ramus preserved is 537 mm.; its depth behind the molar 170 mm. (app.), the depth at the posterior end of the symphysis 145 mm. The length of the molar so far as preserved is about 120 mm. The glenoid end of a scapula, in which the long diameter of the glenoid cavity is roughly 175 mm., and part of a tibia were also collected. Numerous other bones seem to have been noticed in the same deposit, which is on and near the beach, and the locality is one which may prove of great importance, although the matrix is much harder than that of the probably contemporary bone-bed of Samos, and the difficulty of obtaining good specimens consequently greater.

IV.—The Imperial Institute Map of the Chief Sources of Metals in the British Empire.[2]

THE Imperial Institute, in continuation of its publications with reference to the mineral resources of the Empire, has now issued a map with diagrams indicating the sources within the Empire of the chief metals of commercial importance. The outline map shows the occurrence in each British country of the important metallic ores and also the existence of deposits at present unworked. The locality for each occurrence is not given in detail, but only a general statement, carried out by printing the names of the metals therein found in large type across the face of the country. Asterisks indicate existence of unworked deposits in producing countries, while brackets show the existence of unworked deposits in non-producing countries. Diagrams are also given, showing in a graphic form the production of metal or ore in each producing country; these statistics are given for the year 1915: since that date many and important changes have occurred, although no doubt it would be difficult, if not impossible, to obtain complete and reliable figures for the later years. The diagrams also show in an instructive manner the relation of the output of the British Empire to those of other countries of the world. The facts here set forth, when carefully studied, afford much food for reflection.

In the first place it is to be noted that practically every British country, colony, or dependency produces metal or ore of some kind or another, and the British Empire as a whole is a producer of nearly every metal of practical importance, the only really notable exceptions being platinum and mercury; for these we are entirely dependent on foreign supplies.

One of the most striking features disclosed is that more than half the total production of gold of the world comes from within the British Empire, the largest producer of any country being South Africa; the annual value of the gold output of this region is now in the neighbourhood of £40,000,000 per annum. Unfortunately,

[1] Gaudry, *Animaux fossiles et Géologie de l'Attique*, 1862, p. 142.

[2] With diagrams of production for 1915. Published by the Imperial Institute, 1918. Price mounted on linen 5*s*. 6*d*.

owing to the prevailing abnormal economic conditions, gold-mining is now labouring under peculiar difficulties, since gold is the only commodity whose price cannot fluctuate; hence, while mining costs rise, the selling price cannot be increased to correspond. For this reason some low-grade propositions have been obliged to shut down, and the total output has fallen off. Since the Rand mines work on a very small margin of profit, they have been specially hardly hit by these untoward circumstances, and some form of Government subsidy has been suggested as a remedy. It is to be noted that gold occurs in every country of the Empire, even in the British Isles, though the amount now actually mined in the latter is very small indeed. On the other hand, Australia, Canada, and India are all the homes of well-known gold-fields. From the mineralogical point of view one of the most interesting occurrences is the telluride gold-ores of Western Australia; this is a rare type, but is known also in Colorado and in Hungary.

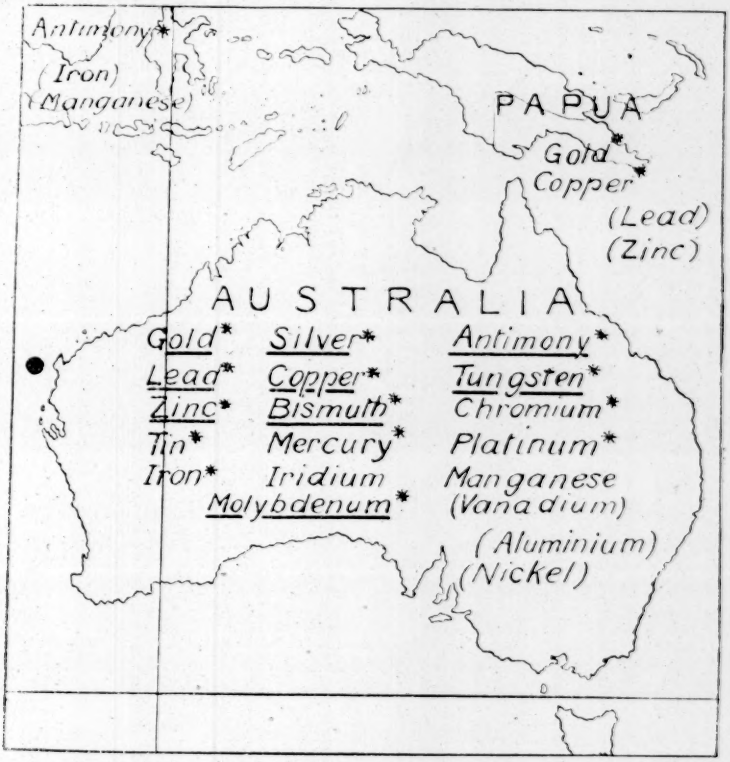
Of silver the British Empire yields between one-fifth and one-sixth of the world's annual supply, Canada being an easy first in this respect with 26,600,000 oz., Australia coming next with 8,780,000 oz. South Africa and New Zealand show rather under a million ounces each, while the rest are nowhere.

Perhaps the most striking fact in the mineral wealth of the Empire is the dominant position held by it in the tin industry. Out of a total annual yield of about 100,000 tons, in 1915 the Empire produced 67,000 tons. As is well known, tin has now reached fabulous prices, and the value of this output is very great. The Malay States alone are responsible for nearly 50,000 tons of tin, thus yielding considerably more than all the rest of the Empire put together, and half the total world's output. The other important British tin-fields are the United Kingdom, Queensland, and Nigeria. In Cornwall there has lately been a considerable recrudescence in tin-mining, and this has been assisted to a certain extent by the tungsten boom.

In lead and zinc Australia easily takes the lead over all other British countries, producing about three-fourths of the lead and nine-tenths of the zinc. A very large proportion of this comes from the wonderful deposits at Broken Hill in New South Wales. A very notable recent addition to our resources of these two metals is the Bawdwin Mines in Burma, which are now undergoing rapid development and seem likely to become an important increment to the world's supply in the immediate future.

With regard to nickel the facts are very striking. There are only two really important nickel fields in the world, namely Canada and New Caledonia. In 1915 Canada yielded almost exactly three-fourths of the nickel of the world, mainly from the well-known occurrences at Sudbury in Ontario. This has been frequently described and is of great scientific as well as economic interest. A promising occurrence of a somewhat similar nature has lately been discovered at Insizwa in Zululand, and it is hoped that when conditions improve this may also turn out to be a practicable source of nickel. It seems probable that in the immediate future cobalt will

to a certain extent replace, or at any rate help to economize, supplies of nickel; the two metals are very similar in their properties, and for some purposes cobalt is actually superior; cobalt alloys, such as stellite, are already used for a good many purposes.



Note.—In the large sheet-map of the British Empire each British possession is coloured pink, and the names of the various minerals found are printed on or adjacent to the same county as shown in the above map of Australia, taken from the large world-chart.

It is hardly necessary to enlarge on the importance assumed by tungsten in the last four years as a munition of war. Until 1914 the tungsten metal industry was almost entirely in German hands, although the greater part of the ore was obtained from the British Empire and the United States. For a time Burma was the largest producer, but is now surpassed by the United States. Some countries already show signs of exhaustion, partly owing to improvident methods of mining in the last four years, but it seems probable that certain newly opened-up localities, such as China, Korea, and Manchuria, will be able to yield a good supply for many years to come. In addition to Burma, the Empire also possesses important tungsten resources in the Malay States, Australia, and New

Zealand, while there is also a prospect of considerable development in the scheelite deposits of Rhodesia. In the last few years there has also been an increased demand for molybdenum and vanadium for the manufacture of special steels. The price of molybdenum is now very high, and important deposits are being worked in Canada and New South Wales.

Turning now to the highly important subject of iron ores, some interesting facts are revealed. In the first place it is shown that the British Empire yielded in 1915 only about one-tenth of the world's output, but the most notable fact is that the United Kingdom alone produced approximately seven-eighths of this, namely 14,235,012 tons out of a total of 15,890,827 tons. Among British colonies by far the most important source of iron-ore is Newfoundland; the Wabana mines in that island are among the largest in the world and the reserves are enormous. Shipping facilities are also very good and prospects are most brilliant. During the War years very special efforts have been made to keep up the supply of British ore in order to save transport, and the efforts of the Ministry of Munitions have been successful in this respect. Important developments have taken place, particularly among the Jurassic ores of the Midlands, and improved methods of mining and transport have been introduced. Efforts have also been made to develop home resources of manganese: in 1915 India produced more than half the manganese ore of the world and practically the whole of the output of the Empire, other British countries accounting for only 6,000 tons. In chromium ore Rhodesia takes the lead with nearly one-third of the world's output, while Canada comes next. The chromite deposits of Unst, in the Shetland Islands, have recently been worked to a considerable extent.

From the facts above detailed it will be seen that the British Empire plays no mean part in the world of metals. In the case of most of them it occupies a position of prominence, and in some of pre-eminence. Furthermore, it is known that in many parts of the Empire there are large undeveloped, or partially developed, deposits forming a reserve for the future. It is to be hoped that in the period of reconstruction and development which will in all probability succeed the past disastrous years, those who control such matters will be inspired to adopt a wise and prudent policy, taking into account conservation as much as development, and thus laying the foundation of a long-continued period of prosperity and happiness for the inhabitants of the Empire.

R. H. R.

REVIEWS.

I.—New Bennettitean Cones from the British Cretaceous. By M. C. Stopes. Phil. Trans. Roy. Soc. Lond., ser. B, vol. ccviii, pp. 389–440, 6 pls., 25 text-figs., 1918.

PROBABLY no genus of Mesozoic plants has excited such interest among botanists as *Bennettites*, or, as Professor Seward and others prefer to call it, *Cycadeoidea*. This interest was greatly

stimulated by the results of Wieland's study of a large number of American fossil Cycadophytes, which were thought by some workers to throw light upon the vexed question of the origin of the Angiosperms. A full knowledge of these plants is thus particularly desirable, and we must welcome descriptive work dealing with them, even when—as is the case in the memoir before us—the author has not been so fortunate as to add anything of material importance to what was already known.

The first section of Dr. Stopes' paper consists of a description of a portion of a cone, *Bennettites albianus*, sp. nov., recently obtained from the Gault of Folkestone Warren. The specimen was petrified and proved suitable for sectioning. The author concludes that this cone was "*the* giant fruit of the family". The fragment available, however, measured only 5·5 cm. × 3 cm. in transverse section, and the idea that the cone was of peculiarly large size is deduced from a reconstruction of its probable shape when complete; this may be perfectly correct, but it must be regarded as at present scarcely proven. The seeds with their embryos and seed-coats, and the interseminal scales, are discussed and figured in detail. The author describes the outermost layer of the seed covering as a "cupule" or "aril" of elongated tubular cells. She regards the plug of tissue closing the micropyle as nucellar in nature.

Carruthers' type-specimen of *Bennettites maximus* has hitherto been known only by its external characters, and so much of its anatomy as could be observed with a hand lens. In the second part of her paper Dr. Stopes records the results she has obtained by having this specimen sectioned. The most notable feature is the occurrence of extremely young cones. One of these, of which preparations were obtained, shows in one section a collar of tissue surrounding the peduncle, which the author interprets as a whorl of male sporophylls. She writes: "The discovery that this species had *bisporangiate cones* is, of course, the feature of supreme interest in the plant." When we consider, however, that the existence of male sporophylls is deduced from a single section in which no synangia are preserved, we can scarcely avoid feeling that, although the truth of Dr. Stopes' view is highly probable, it must at present be received with some degree of reserve.

A. A.

II.—Yorkshire Type Ammonites. Edited by S. S. Buckman; photographs mainly by J. W. Tutcher. Part XVI. 8 plates, and descriptions Nos. 112–116. London: Wesley. 1918. Price 3*s.* 3*d.* net.

THE present part of this most systematically edited publication deals with five Ammonite species: *Arnioceras semicostatus* (Young & Bird); *Perisphinctes rotifer* (Williamson-Brown); *Hildoceras bifrons* (Bruguière); *Pachyceras rugosus* (Leckenby); *Vertumniceras vertumnus* (Bean-Leckenby). This last is a new genus of the family Cadoceratidæ; of the four paratypes of the species (which, with the holotype, are in the Sedgwick Museum) two are referred to

Quenstedticeras damoni, Nikitin, and a third is made holotype of *Vertumniceras spatiatum*, n.sp.

Of the species herein dealt with, *Hildoceras bifrons* is probably the best, as it is also the longest, known. Mr. Buckman thinks it highly probable that the specimen represented in his plate cxiv A is the original of Martin Lister's figure (1678, Hist. Anim. Angl.), which, through Bruguière's reference to it, became the holotype. The specimen is now in the collection of Mr. V. E. Robson, F.G.S., who "purchased it in London". London is a big place, so that this statement does not throw much light on the previous history of the specimen. Indeed, our friend Mr. S. Holmes, Intelligence Department, regards it as a transparent blind.

III.—The Ossiferous Caves near Torquay.

IN the Journal of the Torquay Natural History Society for 1918 Mr. Harford J. Lowe has given an interesting account of the comparatively little-known Tor Bryan Caves, near Torquay, together with a short biography of Mr. J. L. Widger, who spent some twenty years of his life in excavating them. Unfortunately his enthusiasm appears to have been greater than his knowledge of what is required in making such an excavation, and consequently much valuable information has been lost. Mr. Lowe discusses the probable history of the caves and their relation to Kents Cavern and Brixham Cave. He considers that the human occupation of these caves was much later than that of Kents Cavern. The greater part of the Widger Collection is now in the British Museum.

F. A. B.

IV.—Report on certain Minerals used in the Arts and Industries. III. Magnesite. By P. A. Wagner. South African Journal of Industries, Pretoria, 1918.

IN this bulletin Dr. Wagner gives a general account of the properties and uses of magnesite and describes the occurrences of the mineral in South Africa. Since the supplies from Austria-Hungary and Greece were cut off by the War a considerable magnesite industry has developed in Canada and California, largely for use as a lining in basic open-hearth steel furnaces in the form of bricks. It is also much employed in the manufacture of cement for various purposes, such as floors and ceilings. For all these uses it must be fairly pure, and the supplies of really good quality material are somewhat limited. Up to the present magnesite mining in South Africa has been confined to the Barberton district, where it is found in considerable quantity in the basic and ultrabasic igneous rocks of the Jamestown series. There are also important deposits in the valley of the Olifants River, in the Lydenburg and Pietersburg districts, as veins in highly decomposed pyroxenite belonging to the Bushveld complex. The material produced is now for the most part used by the Union Steel Corporation for linings of electric furnaces at Vereeniging. Otherwise the local demand is small and the establishment of an export trade does not at present seem probable.

R. H. R.

V.—The Corundum of the Zoutpansberg Fields and its Matrix. By P. A. Wagner. Trans. Geol. Soc. S. Africa, vol. xxi, pp. 37–42, with 4 plates, 1918.

SOUTH Africa now ranks as the leading country in the production of corundum, having an output of about 400 tons per month. This comes chiefly from the Zoutpansberg and Leydsdorp fields. The greater part of the mineral occurs either as eluvial crystals and fragments, or as "boulder" corundum, that is rock-fragments containing it along with other minerals. In this paper the characters of the corundum crystals are fully described and analyses given. It is shown that the mineral occurs as a constituent of a pegmatite of dioritic type (plumasite-pegmatite) intrusive in the Swaziland series and in various dioritic and gabbroid rocks, probably belonging to the same phase of igneous activity.

R. H. R.

VI.—Contributions to the Mineralogy of Black Lake Area, Quebec. By E. Poitevin and R. P. D. Graham. Canada Department of Mines, Geological Survey, Museum Bulletin No. 27, pp. 82, with 12 plates and 22 text-figures. Ottawa, 1918.

THE Black Lake area is situated in Megantic county, province of Quebec, and includes one of the most productive portions of the great "serpentine belt". Mining is carried on for asbestos and chromite, and in the course of these operations many interesting minerals have been found. Besides serpentine, other igneous rocks are found, including pyroxenite, gabbro, granite, and aplite, as well as other more basic varieties. The minerals include sulphides, carbonates, and a large variety of silicates: only a few of the more interesting types can be mentioned here, such as very well-developed crystals of diopside, garnet, vesuvianite, zircon, stichtite. Many of these minerals are rich in lime and are believed to be partly due to magmatic concentration after differentiation of an igneous magma, the solutions thus formed circulating through the rocks and reacting with their earlier constituents.

R. H. R.

VII.—Analyses of Canadian Fuels. Part I: The Maritime Provinces. Part II: Quebec and Ontario. Part III: Manitoba and Saskatchewan. By E. Stansfield and J. H. H. Nicolls. Canada Department of Mines, Bulletins 22, 23, and 24. Ottawa, 1918.

THESE Bulletins consist of a collection of analyses of coal, peat, oil, oil shale, and natural gas from a large number of localities within the areas specified. The work has been in progress for several years, first at McGill University and afterwards at the Department of Fuels and Fuel-testing, Mines Branch, Department of Mines, Ottawa. The data given are proximate and ultimate analyses, calorific value, fuel ratio, and carbon-hydrogen ratio. The geological relations of the different deposits receive only the briefest

mention, but the figures given will be very valuable to those interested in the study of fuels.

VIII.—The Geology of Vancouver and Vicinity. By E. M. J. Burwash. pp. 106, with 23 figures and 2 maps. Chicago, Ill.: The University of Chicago Press. 1918.

THE area covered by this report may be divided into two parts: the southern portion, which extends from the international boundary to Burrard Inlet, is part of the floor of the great structural valley in which lie Puget Sound and the Gulf of Georgia; the northern area forms part of the southern margin of the coast range of British Columbia. In the latter the relief of the land is high and yields a definite record of a succession of physiographic cycles. Five such stages can be recognized and correlated with those already worked out in the Cascades of Washington State; they are as follows: the Methow peneplain, represented by accordant summits and terraces, the Entiat stage when mature valleys were developed in this older surface, the Twisp stage when the Entiat valleys were over-deepened by canyons cut in their floors, after uplift, the Chelan stage of glacial modification, and the Stehekin stage of post-Glacial stream-denudation and deposit.

The rocks found in the region include Devono-Carboniferous (Texada and Britannia series), the first wholly volcanic, the second including slate and sandstone as well as lavas, some porphyrite intrusions assigned to the Trias, the Upper Jurassic coast-batholith, Eocene conglomerate, sandstone, shale, and clay, post-Eocene eruptives (Black Tusk basalts), the Garibaldi volcanic formation, and a variety of Quaternary deposits. Of each of these detailed descriptions are given, together with a very complete discussion of the structural and physiographic features attending the formation of each.

The coast-batholith forms part of the immense series of predominantly dioritic batholiths extending from the Frazer River into the Yukon territory. This particular igneous complex includes varieties ranging in composition from biotite-granite through granodiorite, diorite, and gabbro to hornblendite. There is clear evidence of differentiation with marginal basic facies, the latter being in some places intruded by more acid apophyses. Near the contacts gneissoid texture, due to flow, is in evidence, and orbicular types are also known. The Black Tusk basalts form the summits of certain conspicuous mountains, these being probably remnants of flows that filled a Miocene valley, while similar rock-types occur elsewhere as dykes. The Garibaldi volcanics form three cones which are clearly later than some of the Pleistocene glacial deposits: they are mainly basaltic in composition.

Among Quaternary deposits the moraines and various forms of drift are the most noteworthy, since they indicate several stages of glaciation of the region. There are also numerous examples of deltaic and other alluvial deposits, as well as terraces which the author considers to have been formed by glacial lakes.

IX.—The Ruitor Glacier Lakes (Piedmontese Alps). By C. S. Du Riche Preller. Scottish Geographical Magazine, vol. xxiv, pp. 330–342, with 5 text-figures, 1918.

THE author gives a detailed description of several small lakes, some of very recent origin, formed in the course of the retreat of the Ruitor glacier, either at its margin or at the frontal base of the glacier tongue. Some of these lakes, which bear some resemblance to the Märjelen See of the Bernese Oberland, have at times been the cause of disastrous floods in the Dora Baltea valley.

X.—New Zealand Geology.

1. The Stratigraphy of the Tertiary Beds of the Castle Hill or Trelissick Basin. By R. Speight. Trans. New Zealand Inst., vol. xlix, pp. 321–56, 1916.

THIS basin, which is situated in the heart of the mountain region of Canterbury, is about 8 miles long by 4 miles wide, and contains an interesting series of sedimentary deposits, with some volcanic material. The strata, which consist of sands and sandstones, greensands, shale, coal, and limestones, are richly fossiliferous. Certain beds low in the series contain plant remains of decidedly Tertiary character, including *Quercus*, *Planera*, *Dryandra*, and *Cassia*, but these are overlain by marine sediments containing Cretaceous shells. Higher still the proportion of recent forms gradually increases, and the author considers that the succession from Cretaceous to Tertiary is continuous, since he finds no indication of unconformity, as maintained by earlier writers.

R. H. R.

2. An Unrecorded Tertiary Outlier in the Valley of the Rakaia. By R. Speight. Trans. New Zealand Inst., vol. xlix, pp. 356–60, 1916.

THE author gives in this paper a description of a newly-discovered occurrence of Tertiary strata in the valley of the Harper River, a tributary of the Wilberforce, which is itself one of the main feeders of the Rakaia, in the Canterbury district. The Tertiary deposits cover an area of some 5 miles long by 2 or 3 broad, and consist of sandy clays with impure lignite, greensands, concretionary sands, and shell beds, the fossils indicating a mid-Tertiary age. The occurrence of the outlier in this position is explained as being due to faulting, the main part of the series having been removed by erosion at higher levels. The walls of the valley itself are remarkably straight and suggestive of a rift, and are parallel to the dominant fault-lines of the whole area, the Kaikoura fractures of McKay and Cotton. This region also affords evidence of some interesting modifications of drainage, which may be due either to very recent movements along fault-lines or to glacial barriers.

R. H. R.

3. Additional Facts concerning the Distribution of Igneous Rocks in New Zealand. By J. A. Bartrum. Trans. New Zealand Inst., vol. xlix, pp. 418–24, with 1 plate and 1 text-figure, 1916.

THIS paper contains petrographical descriptions of nine specimens of igneous rocks from different parts of New Zealand, including both plutonic and volcanic types. A hypersthene basalt from near Whangarei is believed to be the first instance of this rock from that country, although hypersthene is well known in the basic andesites of Tarawera and Tongariro. A peculiar basalt with olivine, augite, and large phenocrysts of biotite from the Wairoa River is often used for ornamental work and is locally called "Kaipara granite". A hornblende basalt is also noted from near Sumner in the South Island. The plutonic rocks include a coarse-grained troctolite with much serpentine from Wade, near Auckland, and various gabbroid and dioritic rocks from the Baton and Graham Rivers, Nelson. These are essentially very coarse-grained hornblende rocks with much ilmenite, epidote, apatite, sphene, and a varying amount of quartz: the hornblende seems to be secondary after pyroxene. Some boulders of dioritic rocks with gneissic structure were found at Albany, near Auckland: they probably come from a Miocene boulder-bed. Diorites seem to have formed an important element in the pre-Tertiary terrain of the Auckland district. A specimen of granodiorite from Reefton, in the Nelson district, which was apparently collected from a river gravel, is remarkable in that it contains what appears to be primary epidote. It is a rock of granitic appearance, with abundant biotite and a large variety of felspars, including perthite, microcline, and plagioclase. Both sphene and epidote are very abundant. The epidote, often occurs in well-formed crystals enclosed in felspar or in biotite. Crystals of brown hornblende are often enclosed in the epidote, and the author regards the primary character of some at least of the epidote as established.

Although the rocks here described come from widely scattered localities and may be of very different ages, nevertheless they all show more or less clear sub-alkaline characters. One specimen only, from Wairau Creek, Milford, Auckland, is described as a trachyte, and even this does not seem to be a very alkaline rock. However, no analyses are given, so that this point cannot be decided.

R. H. R.

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4. The Volcanic Rocks of Oamaru. By G. H. Uttley. Trans. New Zealand Inst., vol. l, pp. 106–17, 1918.

IN this district there are three horizons of volcanic rocks—the Waiareka tuffs, the Kakanui breccia, and an upper lava, the latter shows many of the characters of the pillow lavas, but they cannot be classed with the spilites, since the proportion of soda-felspar is very low. It was, however, erupted under marine conditions, but in shallow water. The stratigraphical breaks and the limestone conglomerate can be explained on the assumption that volcanic islands were rapidly formed and rapidly destroyed: hence the unconformities introduced into the Oamaru system by other observers

are of merely local value, and the succession is really continuous throughout.

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5. On the Age of the Waikonaiti Sandstone, Otago. By J. Allan Thomson. Trans. New Zealand Inst., vol. l, pp. 196–7, 1918.

MOST geologists have correlated this sandstone with the Otatara limestone, but the discovery in it of *Pachymagas abnormis* leads the author to conclude that the sandstone belongs to the Upper Oamaruian, possibly to the Awamoan.

REPORTS AND PROCEEDINGS.

I.—Geological Society of London.

November 6, 1918.—G. W. Lamplugh, F.R.S., President, in the Chair.

The President read a communication that he had received from Professor Charles Barrois, D.Sc., F.M.G.S., in reply to congratulations sent on the occasion of the evacuation of Lille by the enemy forces.

A discussion on the Antarctic Ice-cap and its Borders was introduced by Sir Douglas Mawson, D.Sc., B.E., F.G.S.

Sir Douglas Mawson said that at the last meeting of the Society[1] the subject of the Antarctic Ice-cap was reviewed in its broader aspects, chiefly with the view of promoting a discussion among those specially interested in Glaciology. The present occasion had been reserved for the discussion, and he proposed to show certain lantern-slides in order to bring the salient features freshly to mind.

Though much of the foundation of the Antarctic Ice-cap is certainly elevated land, it is quite possible that elsewhere the dome rests upon a floor actually below sea-level. In any case it is most probable that the smooth ice-surface masks a very irregular rock-basement. The thickness of the ice may, therefore, be expected to be extremely variable, no doubt reaching a maximum of several thousands of feet.

An ice-formation of such magnitude introduces questions relating to the flow of its substance and the abrasion of its foundations which do not enter into the physics of ice-masses of smaller dimensions. Here the static pressure on the lower zones of the ice may reach 1 ton per square inch. At the same time, the temperature may be so increased by ground heat as to be much higher than that prevailing above. As a consequence, when the ice-formation is very thick, a more plastic base must be admitted.

The outflow of the inland ice is principally deflected at the coastal margin into depressed areas outlining the heads of gulfs and bays. In such localities the rate of movement and the volume of ice entering the sea are both great. So great indeed, that extensive

[1] See Reports and Proceedings Geol. Soc., June 19, 1918, Geol. Mag., August, 1918, pp. 379–80.

floating "glacier tongues" are a feature of such situations, often extending 40 to 50 miles from the shore.

Along other stretches of the coast less well placed for receiving contributions from the interior of the Continent, the outflow is so much less that the destructive influences at work on reaching the sea easily maintain its boundaries at approximately the true coastline.

As exceptions to this latter prevailing condition, however, there are known already two notable localities where the general overflow from the land maintains itself as an immensely thick floating structure extending far out over the sea—a veritable oceanic ice-cap. To this type of formation we apply Professor Nordenskjöld's term "shelf-ice". The formations referred to are the Great Ross Barrier at the head of the Ross Sea and the Shackleton Shelf off the coast of Queen Mary Land.

The former occupies what is really the head of the Ross Sea—a somewhat triangular area. From apex to base it measures 500 miles, with a base-length of about 400 miles. This great raft of ice presses forward to the open sea at the rate of a few hundred yards per annum. The available figures, quoted by David and Priestly, show that, at the present rate of advance, the ice now appearing at the sea-face must have left the inner extremity of the floating sheet at some time during the seventh century. A survey of the ice-cliff forming the sea-face indicates by its changing height that the Ross Barrier is of varying thickness. This has been explained by the presence, in localities where it is thickest, of the remnants of the massive ice contribution received during its course from certain of the large tributary glaciers. The ice from these glaciers, in fact, constitutes a strong framework which stiffens and contains the more crumbling structure derived from the consolidation of the annual snowfall.

To a great extent this must certainly be so; but the influence of a varying snowfall, and the effect of violent periodic winds—a feature of the region—in sweeping the loose snow from certain areas and depositing it in other favoured localities, must be reckoned with. The snowfall is lighter on the eastern side than on the west. Furthermore, the snow tends to accumulate on the western side owing to the fact that the winds regularly blow from the quarter south to east, and not from the west.

In the case of the Shackleton Shelf, this is the more remarkable because it maintains itself as a pontoon stretching into the open sea, even across the drift of the prevailing ocean-current.

The deluge of ice, after descending to the sea, presses northwards as an integral whole, at first touching bottom at intervals, then forcing its way past several islands, eventually reaching an extreme distance of 180 miles from the land before it is mastered by the swell and currents of the Southern Ocean. It is somewhat triangular in form, with the apex out to sea. The base against the land, though not completely charted, extends in all probability for a distance of about 200 miles.

The main body of the shelf-ice advances rather slowly, but the Denman Glacier, which contributes to it, has a much more rapid

movement, very well illustrated by the fact of its ploughing through the other shelf-ice with such force that a shatter-zone some miles wide is developed.

The wall of the shelf-ice on the west side offers an excellent example for study, as it is a section from the point of its departure from the land to its crumbling apex. In the case of the Ross Barrier, the cliff-face is a section across the direction of movement.

At the land end, the Shackleton Shelf, from the surface down, is hard glacier-ice breaking with a characteristic fracture. A few miles farther out, away from the influence of the winds descending from the land slopes, a nevé mantle commences to make its appearance over the original ice-formation. As one steams along the face away from the land, this capping is observed to increase steadily in thickness. The overburden of nevé is arranged in regular bands, each of which corresponds to a single year's addition. This being so, it is possible to make some sort of an estimate of the age of the formation.

The weight of these additions depresses the top of the original ice below the surface of the water. Though there is a regular annual addition above, it must not be imagined that the total thickness of the pontoon is correspondingly increased; for the solution of the lower surface by the sea has also to be reckoned with. Very often, however, in the nevé sections of glacier-tongues the cliff-face above the water is observed to stand higher than in the wholly ice zone at the land end. This is to be expected on account of the lighter nature of the nevé ice added, there being a larger proportion of air sealed up in it.

The observed height above sea-level of Antartic shelf-ice so far recorded ranges from about 20 to over 200 feet. A common figure is from 90 to 120 feet, suggesting a total thickness of 600 to 1,000 feet.

Although the height of the cliff-face presented by shelf-ice gives some idea of its total thickness, a really accurate method of determination is badly needed. The Australasian Expedition hit upon a method which gives positive results in some cases at least. This consists in taking serial temperatures of the sea-water in depth near the face of the shelf-ice. As there is always a current flowing beneath the ice, the bottom of it is likely to be marked by a sudden slight change in the water temperature, easily observed when the observations are plotted as a graph.

The President conveyed the thanks of the Society to Sir Douglas Mawson for his luminous description of Antarctic conditions and for his selection of the magnificent illustrative photographs on this as well as on a former occasion. The fact that the explorer was in this case a thoroughly competent geologist was indeed fortunate. The Fellows had been thus enabled to participate without effort in the new knowledge gained through heroic labour by the lecturer and his comrades. A further privilege was afforded to the Glacial geologists present by Sir Douglas Mawson's readiness to impart the information that he, more than any other man, possessed, and, as time was limited, the President hoped that the speakers would take advantage of this privilege rather than give expression to their particular views.

For his own part, he would like to ask at once whether the lecturer had formed any opinion as to the origin of the evidently bold land-features that were buried under the ice—could they have been carved out by the ice itself, or were they the relics of a time when the land was ice-free?

In the discussion which followed, Professor P. F. Kendall, Sir Henry Howorth, Dr. J. W. Evans, Mr. G. W. Young, Mr. A. E. Kitson, and Dr. A. Strahan took part.

The President supplemented the questions by asking whether the lecturer could express any opinion as to (1) whether, if the great table of shelf-ice continued to grow by accretion, it would eventually become merged into the main ice-sheet; (2) how much of the remarkable seaward extension of the huge ice-tongues was due to forward flow, and how much to growth-in-place by snowdrift; and (3) what happened when an advancing ice-front over-rode a rocky island well separated from the mainland?

Sir Douglas Mawson, in replying, said that he would take the President's questions first. As to the origin of the land-features, he did not want to commit himself on this difficult point at present, but was inclined to think that the physiography, so far as one sees it, might all have been produced by ice if no other agency had been available; but it was most likely that the ice started upon a surface already sculptured to some extent. He felt sure, however, that the Antarctic ice could and did cut deep channels, not only above but also below sea-level. Where the ice was thickest it burrowed fastest, and tended, therefore, always to accentuate any existing hollow.

As to the growth of the shelf-ice, although there was a large accretion at the top by snow swept off the land, there was also probably much dissolution below by the action of the sea-water; so that the net increase of the mass was not so rapid as appeared at first sight.

That there was forward movement of the ice-tongues was proved by the way in which they ploughed through the fixed shelf-ice and by their upward bulging where they struck bottom; but most of their movement was over sea-water, and therefore easy and almost frictionless.

Where the ice-sheet abutted upon an island, it depended upon the relative proportions of ice and land whether the land was entirely over-ridden or the ice-flow split and diverted. Examples of both phenomena were observed.

As to the rate of wastage by melting, the great ice-plateau by causing an outflow of cold air kept the temperature at the ice-margin too low for much melting. What melting there was depended mainly upon the lie of the ice-slope in relation to the sun. There was also a good deal of wastage both of snow and ice by direct evaporation, depending upon the season. But the main wastage was due to the descending winds, which fiercely and almost continuously swept the outer slopes.

With regard to the thickness of the ice, there was perhaps no direct evidence, but a great amount of indirect evidence all indicating

that it must in places be very thick—probably several thousands of feet. Boring had been thought of, but would be impracticable because of the movement of the mass at differential rates, so that the borehole could not be kept plumb or open. There were some new instruments, however, invented for marine purposes, which might eventually yield positive information.

The banding of the ice was not due to dirt or dust, which was practically absent in the Antarctic, but to differences of structure and density, marking the seasons.

The rugged surfaces of the islets are probably due to frost-splintering and marine action, and do not imply that they have suffered no ice-erosion.

The drift deposits are scanty, because there is so little flat land exposed on which they could accumulate. But the sea-bottom carries a great accumulation of clay with boulders for a long distance northwards from the present ice-front.

The Secretaries of the Society are desirous of completing a record of the services rendered by the Fellows in connexion with the present War. Details of service, with a statement of rank, regiment, military honours, and any other information, will be gladly received from Fellows, either with reference to themselves or to those known to them.

II. Liverpool Geological Society.

November 12, 1918.—J. H. Milton, F.G.S., F.L.S., Ex-President, in the Chair.

The following paper was read:—

"Notes on Pebbles in their Geological Associations." By William Hewitt, B.Sc.

The paper gave the results of a comprehensive study of the physical characters of pebbles and their production, and embodied a large amount of statistical and other information relative to their sizes and shapes, the transporting power and velocity of streams, and the varying conditions under which pebbly deposits have been accumulated. The more important conglomerates of the geological series were also briefly considered. Recent observations by Mr. Hewitt as to the number and size of the pebbles (from about one-tenth of an inch long and upwards) in the Bunter Pebble Beds in four different localities in the Liverpool district, where the pebbles are most conspicuous, gave the following result:—

	Total surface.	Total No. of pebbles.	Longest diameter. Up to 1".	1-2".	2-3".	Over 3".
Vertical sections .	32 sq. feet	723	676	36	10	1
Horizontal sections .	22¾ ,,	1,012	974	36	1	1

The greater number of pebbles shown in the horizontal sections confirms previous observations as to the occurrence of pebbles mainly at distinct horizons; in some cases they constitute small gravel pockets. The majority of the pebbles were under half an inch in their longest diameter, the largest one seen was 6 inches long. An

estimate of the relative proportion of the surface of section occupied by pebbles ranged in vertical faces from 3 to 9 per cent and in horizontal faces from 4 to 16 per cent with one exceptional case of 32 per cent. (The percentage of the rock mass formed by the pebbles is certainly distinctly lower than the surface percentage.) This condition of the Liverpool Pebble Beds is in marked contrast to the Bunter conglomerate beds of the Midlands (Cannock Chase, etc.) or Budleigh Salterton.

III.—Mineralogical Society.

Anniversary Meeting, *November* 5, 1918.—Sir William P. Beale, Bart., K.C., M.P., President, in the Chair.

The following were elected Officers and Members of Council: President, Sir William P. Beale, Bart., K.C., M.P.; Vice-Presidents, Professor H. L. Bowman, Mr. A. Hutchinson; Treasurer, Dr. J. W. Evans; General Secretary, Dr. G. T. Prior, F.R.S.; Foreign Secretary, Professor W. W. Watts, F.R.S.; Editor of the Journal, Mr. L. J. Spencer; Ordinary Members of Council, Mr. H. Collingridge, Mr. T. Crook, Dr. G. F. Herbert Smith, Dr. H. H. Thomas, Mr. H. F. Collins, Mr. J. P. De Castro, Professor H. Hilton, Lieut. A. Russell, Dr. A. Holmes, Miss M. W. Porter, Mr. R. H. Rastall, Sir J. J. H. Teall, F.R.S.

The following papers were read:—

Dr. G. F. Herbert Smith and Dr. G. T. Prior: "On a Plagionite-like Mineral from Dumfriesshire." Specimens of antimony-lead ore collected by Lieut. Russell from Glendinning mine contained small cavities lined with tiny black crystals, measuring less than 0·4 mm., and mostly less than 0·2 mm. across. Some resembled in habit the crystals of plagionite from the Hartz Mountains described by Luedecke. Measurements made on the three-circle goniometer showed the crystals to belong to the semseyite end of the group, and the result of a chemical analysis of the compact material of which the crystals form part corresponded approximately to the formula $5\,PbS\,.\,2\,Sb_2S_3$. Semseyite has not previously been recorded from the British Isles.

Lieut. Arthur Russell: "The Chromite Deposits in the Island of Unst, Shetlands." The bottle-shaped mass of serpentine which runs through the centre of the island from north to south contains chromite uniformly distributed, but varying greatly in character, being at times massive, but generally granular. Over thirty quarries are known, but only six of them have been worked to any extent. The associated minerals include kämmererite (abundant in one quarry), uvarovite, copper, hibbertite, brucite, calcite, talc, and magnetite. The rocks other than the serpentine are poor in minerals.

Dr. G. T. Prior: "The Nickeliferous Iron of the Meteorites of Bluff, Chandakapur, Chateau Renard, Cynthiana, Dhurmsala, Eli Elwah, Gnadenfrei, Kakowa, Lundsgård, New Concord, Shelburne, and Shytal." The percentage of nickeliferous iron and the ratio of iron to nickel in the several instances were found to be

respectively—5, 6½; 8, 9; 8½, 6½; 6, 6; 3½, 3½; 6½, 7½; 21½, 12½; 8, 6; 8½, 7; 10, 8; 10½, 10; 7½, 6½.

CORRESPONDENCE.

THE HORIZON OF *PRODUCTUS HUMEROSUS*.

Sir,—In reply to Dr. Wheelton Hind's letter in the October number of the Geological Magazine, may I point out that there appear to be two forms of *Productus humerosus* occurring at different horizons. The earlier form is evidently characteristic of the Belgian "*sub-lævis*" level (C–S), while the later mutation is found in the *Dibunophyllum* zone. The late Dr. Vaughan, in his paper on the "Correlation of Dinantian and Avonian", published in the Q.J.G.S., vol. lxxi, No. 281, refers to this matter, and mentions, on p. 47, that the Clitheroe form is the early variety of *Productus sublævis*. For the present I conclude, from evidence stated in my paper, that the Leicestershire beds contain the later advanced form of *P. humerosus*, and are of D_1 age, but I am looking forward to reading, with much pleasure, Dr. Hind's forthcoming paper on the Clitheroe area, and will then carefully reconsider the question.

L. M. Parsons.

110 Lewin Road,
Streatham, S.W. 16.

OBITUARY.

SAMUEL WENDELL WILLISTON, M.D.

Born July 10, 1852. Died October, 1918.

Vertebrate palæontology loses a distinguished student by the death of Professor S. W. Williston. After leaving school he entered the Kansas Agricultural College, where his interest in geology was roused by Professor B. F. Mudge. He was then employed by Professor O. C. Marsh as one of his fossil-collectors in Kansas and other western territories of the United States. At the same time he helped with the preparation of the fossils in the Yale University Museum, and also pursued medical studies, which eventually led to his graduating as M.D. He was deeply interested both in the fossils and in the living animals which he met with during his explorations, and so early as 1877 he began to publish small notes. Professor Marsh, however, discouraged Williston's researches on fossils, and he therefore turned in earnest to dipterous insects, on which he became one of the leading authorities in the United States. In the early eighties he was appointed Professor of Geology and Palæontology in the State University of Kansas at Lawrence, where he brought together a great collection of fossils from the Cretaceous and Carboniferous formations of the State. In 1902 he removed to the newly instituted chair of Palæontology in the University of Chicago, where he continued active researches until nearly the time of his death.

While at Lawrence, Williston's most important work was his investigation of the reptiles found in the Chalk of Kansas, and the results were finally summarized in a well-illustrated volume of the University Geological Survey of Kansas (vol. iv, Palæontology, pt. i) published in 1898. In his early years at Chicago he continued these researches, and his valuable papers on Plesiosaurs and Pterodactyls in the Publication of the Field Columbian Museum, No. 78 (1903), may be specially mentioned. He also published a little semi-popular volume on *Water Reptiles* (1914). During the last decade he devoted attention chiefly to the Permian Reptiles from Texas and Missouri, describing important collections which he acquired for the University of Chicago. These form the subject both of numerous papers and of a small well-illustrated volume on *American Permian Vertebrates*, issued by the Chicago University Press in 1912. Many of the papers not only describe the fossils, but also discuss the bearing of the new facts on some of the most fundamental problems of vertebrate morphology. A complete list of Williston's papers up to date, prefaced by a beautiful portrait, was printed by J. T. Hathaway at New Haven in 1911.

Williston was an attractive personality and left many devoted pupils, of whom some have already made important contributions to the science of which he was so successful an exponent.

A. S. W.

MISS MAUDE SEYMOUR.

Born 1887. Died November 6, 1918.

Those Fellows of the Geological Society who have been accustomed to use the Library during the last few years will hear with much regret of the death of Miss Seymour, who was appointed as an assistant in the Library on September 1, 1915. The valuable experience gained during several years of training on the staff of the Royal Society's Catalogue of Scientific Papers gave her the advantage of a special knowledge of the literature with which she had to deal. She devoted herself to the work with marked ability, and her unflagging zeal and amiability of disposition substantially relieved the pressure of an exceptionally harassing period. During this time she gained an intimate knowledge of the work involved in the preparation of the *Geological Literature*; and by her sudden and untimely death the Geological Society has lost a valuable official whom it will be difficult to replace.

MISCELLANEOUS.

Swiney Lectures on Geology.

The lectures for the years 1918–1919 will be given by Professor T. J. Jehu, M.D., F.R.S.E., at the Royal Society of Arts, John Street, Adelphia, W.C., on various days during the months of December, 1918, and January, 1919. The title chosen for the course is "Man and his Ancestry", and the published syllabus of the twelve lectures promises a comprehensive treatment of this important subject. Admission to the lectures free.

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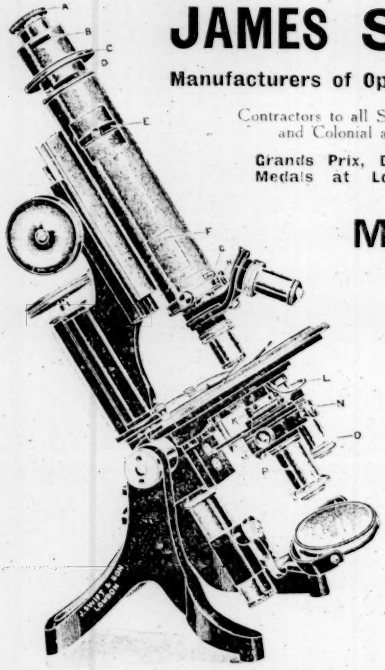

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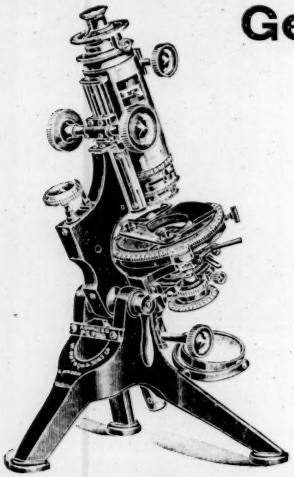

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